Available at www.sciencedirect.com

INFORMATION PROCESSING IN AGRICULTURE 3 (2016) 207–214

journal homepage: www.elsevier.com/locate/inpa

Determining an optimum pattern of mixed planting from organic and non-organic crops with regard to economic and environmental indicators: A case study of cucumber in Kerman, Iran

Soraya Molaie Emamzadeh [a], *Mohammad Ali Forghani* [b,*], *Assadollah Karnema* [b], *Samaneh Darbandi* [a]

[a] *Shahid Bahonar University of Kerman, Iran*
[b] *Managment Department, Shahid Bahonar University of Kerman, Iran*

ARTICLE INFO

Article history:
Received 29 December 2015
Received in revised form
9 August 2016
Accepted 13 August 2016
Available online 30 August 2016

Keywords:
Organic agriculture
AHP
Weighted Goal Programming

ABSTRACT

Today, planning procedures which are used in different fields of decision making such as determination of optimum planting patterns are considered as important management issues. The importance of optimum planting patterns is highlighted when we learn that agricultural measures may have environmental side effects. Most economical analyses only focus on increasing economic gains of the farmers without regard to its environmental consequences. Therefore, one can argue that efficient managers should consider multiple purposes that cover both economic and environmental goals at the same time. This study attempted to identify an optimum mixed model of organic and non-organic production systems using a combination of AHP (Analytical Hierarchy Process) approach and Weighted Goal Programming to consider environmental and economic indicators simultaneously. This procedure was employed in the current design to determine and compare an optimum pattern of mixed planting of organic and non-organic products. The study sample was cucumber, investigated in four farming systems: organic open field farming system, non-organic greenhouse farming system, non-organic tunnel farming system and open field non-organic farming system in Jiroft, Kerman, with regard to paper indices. Following the proposed MCDM (Multiple Criteria Decision Making) model, cucumber planting in open field non-organic farming system was replaced by open field organic farming system. Economic and environmental indicators rose by 11.97% and 21.40% respectively in MCDM proposed plan in comparison with the existing farm plan, which indicates the feasibility of MCDM proposed plan in terms of economic and environmental indicators.

* Corresponding author. Fax: +98 32112861.
E-mail addresses: soraya.emamzadeh@yahoo.com (S.M. Emamzadeh), forghani@mail.uk.ac.ir (M.A. Forghani), assadollahkarnema@yahoo.com (A. Karnema), samaneh_db@yahoo.com (S. Darbandi).

Peer review under the responsibility of China Agricultural University.
http://dx.doi.org/10.1016/j.inpa.2016.08.001
2214-3173

1. Introduction

In recent years, environmental health has become one of the most important problems of human due to following reasons: the increase of agricultural products and challenges such as population growth, bigger demands for food due to population growth, lower soil fertility for agricultural purposes, depletion of aquifers, contamination of subterranean water resources, reduction of micronutrients such as zinc, copper and iron in soil, disruption of the biological balance of ecosystems and endangerment of rare wildlife species. Therefore, modern agricultural systems have been strongly criticized for their negative environmental impacts over time [1], that prompted societies across the world to start searching for appropriate guidelines to resolve these issues and achieve stable agriculture systems. Moreover, a global consensus must be reached for environmental protection to facilitate the development of a type of agriculture which can increase productivity while preventing as much as possible environmental damage [2]. The responses given to these concerns have primarily been related to organic agriculture. The development of biologic, ecologic and finally organic agriculture traces dates back to the publications of “Albert Howard”. The word organic and chemical-free production system was used by “North Bern” for the first time in 1940 [3]. Organic agriculture is a system of agricultural production in which chemical fertilizers, pesticides, hormones and chemical and artificial additives are not utilized. Instead, non-chemical methods such as crop rotation, green manure, biological control (other non-chemical methods for controlling pests, diseases and weeds), compost and other similar things are used to strengthen the soil fertility and help control pests, diseases and weeds [4].

The basics of organic agriculture, which are the source of supplying raw materials and the foundation of this production system, are as follows:

- Minimized application of external inputs of production [5];
- Preserving and improving soil fertility through using long-term biological methods (increasing the population soil microorganisms and crop rotation);
- Avoiding the utilization of chemical and artificial products (fertilizers and toxins);
- Encouraging genetic diversity and natural biological cycles [6].

Different solution such as conducting research in organic agriculture have been proposed to solve problems caused by uncalculated application of toxins and chemical fertilizers in general agriculture. Aertsens et al. (2011) studied the effects of individual variables on the consumption of organic products and found out that the knowledge of the physical properties of organic products was one of the most important positive factors, whereas higher price of product and lack of proper access was the most important negative factor affecting this issue. Lack of information and knowledge about the properties of organic products is considered as the main reason for non-consumption of these commodities by American consumers [7].

Bonti and Yiridoe [8], Makatouni [9], Klonsky [10], Gavind and Itlia [11] have reported the following factors influencing the organic products acceptability among people: more accessible information, sex; age, income, education, fewer environmental hazards, crop healthiness, food safety, produce nutritional value, taste and flavor, freshness and crop appearance. Moreover, higher quality and the lower price of organic products compared to conventional products, market continuous demands, less environmental pollution levels and government financial supports of organic farmers make organic systems beneficial to the producers [12–14]. Fresh vegetables and fruit account for 40–50% of the total organic products sale. Furthermore, in England there has been an increasing demand for vegetables, fruit and dairy products in recent years [15]. Zhou and Chen [16] suggested that people could gather information about organic crops from TV, newspapers and internet. Diederen et al. [17] mentioned the farm size as the most important factor in organic agriculture acceptance. Tatlidil et al. [18] showed that vast coverage of promotional services, education, land ownership and higher access to information could lead to a better understanding of agriculture operations. In their research, Lund et al. [19], stated that economical motives were the most important factor affecting acceptance of organic agriculture. Dabbert et al. [20] believes that financial supports of organic farmers plays a key role in the acceptance, persistence and development of organic agriculture.

Moreover, different studies show that after an initial reduction, the function of organic products can reach the same level as general products [21,22]. The function of organic agriculture can even exceed that of general products by 21% [23]. On the other hand, organic farms use 40–65% fewer labor hours to manage plant protection and fertilizing processes [21].

Acs et al. [24] used dynamic linear programming method to compare organic agriculture and general agriculture; the results showed that organic agriculture was more profitable in comparison to general agriculture. Therefore, it seems that the place of study could cause the diversity of agricultural systems [25]. It should be noted that it is not fair to compare general and organic farming systems when research concerning the former system and its developing technologies are much more sponsored than the latter. However, many studies have shown that during the transition from general agriculture to organic farming, the function of agriculture products will experience a sharp fall. However, when the transition time has gone (1–4 years later), the function of the products will return to the previous level and may even increase [26–31]. The existence of different climates as well as high diversity of agricultural and dairy products have resulted in high potentiality and available skills, allowing for establishing and developing organic agriculture in Iran. Notably, referring to the increase of incurable diseases caused by improper nutrition, public health protection groups strongly demand the development and promotion of production and consumption of healthy food. Therefore, some measures have been taken in recent years to produce organic products [32]. FAO official statistics show that the utilization of pesticides in Iran’s agriculture has increased from 1,584,000 tons in 1990 to 7,120,000 tons in 2007 which shows a growth rate of

349.5% during this period [33]. More than 800,000 acres of land in Iran (about 254,000 acres of orchards and 55,4000 acres of agricultural lands) have not been affected by chemical toxins to date. Moreover, according to the latest information, about 12,000 acres of land have been registered for organic agriculture purposes in Iran [32].

1.1. Case study and research activity

Jiroft County which is located in the center of Kerman province, in southeastern Iran, is known as the agricultural hub of the country. The research primarily intended to investigate and compare four different and common farming systems of cucumber in Jiroft County: non-organic managements in greenhouse or tunnel or open field and open field organic ones. The objective was to develop an optimum pattern of organic and non-organic cucumber management, which would cover both economic and environmental indicators at the same time. This objective is in accordance with other goals, such as preserving and improving long term soil fertility, quality and quantity monitoring of food production, creation of a harmonic balance in the production of different crop systems, reduction of various types of water, soil, and air pollution sources, keeping both producers and consumers in a healthy condition, exploration of areas with high potentials for producing organic crop and encouraging a culture of changing common production system (non-organic) toward organic farming system among farmers.

2. Methodology

This paper is based on a combination of two operation research techniques, namely Analytical Hierarchy Process (AHP) and Romero's Weighted Goal Programming [34] to achieve economic and environmental objectives at the same time. Characterized by logical compatibility with human's mind, science and experience, logical and consistent assessment of judgments which are used to define priorities, qualitative criteria measurements; employment of a systematic approach and simultaneous fractionation analysis etc, AHP model is the proper technique for examining the weight alternatives. Moreover, as the present research has a multi-purpose nature and this model is a linear model, weight goal programming best suits this type of problem. For more efficiency, AHP has been combined with WGP to calculate the weight of options in the research mathematical model.

First, the weight of alternatives (open field organic cucumber; non-organic greenhouse, tunnel or open field cucumber) was determined by AHP questionnaires which had been completed by 10 respondents, including 4 agricultural executive experts and 6 professors of School of Agriculture of Bahonar University, Kerman (3 in agricultural economics subdiscipline and 3 in environmental engineering subdiscipline). 'In the next step, a pay-off matrix was created by statistics and the information of the years 2013 and 2014; the weights of research objectives including maximum impure pay-off and minimum utilization of chemical fertilizers and toxins were calculated. Then, weight (alternatives weight) and pay-off matrices (objectives weight) which had been created by AHP were modeled by Weighted Goal Programming (data used in weight goal programming had been derived from the statistics and information collected from the Report of Jiroft Agriculture Department (Kerman) for the year 2013–2014) and solved by MATLAB software. In the end, the optimum answer obtained from Multi Criteria Decision Making (MCDM) was compared with the current design.

2.1. AHP approach

Economic and environmental indicators obtained from the experimental operations were integrated through Multi-Criteria Decision Analysis (MCDA). In other words, AHP and Weighted Goal Programming Techniques are used to integrate environmental and economic indicators in order to rank the alternative scenarios and determine the Optimal Cultivation Pattern [35,36].

Analytical Hierarchy Process as one of the most comprehensive designed methods for decision making with multiple criteria uses binary comparisons of variables and these criteria enable decision maker to solely focus on the comparison of two variables or choices, without any external influence and disturbance. This method was first proposed by Saaty professor of Saint Petersburg University in late 1970s. AHP enables decision makers to determine mutual and concurrent effects of most complicated and undetermined situations and also to determine priorities based on their objectives, knowledge, experience, emotions and judgments [37–40].

2.2. Weighted goal programming technique

As single-objective methods do not deal with different and opposite objectives like in the real world, they are not operational for simultaneous investigation of economical and environmental indicators and cannot fulfill the objectives of both consumers and producers. Therefore, we need methods that can provide optimal answers to achieve planned objectives by considering multiple purposes and the current limitations. Goal Programming is one of these methods that can determine the way of achieving multiple objectives at the same time.

Goal Programming consists of four parts:

1. Decision making variables.
2. System limitations.
3. Goal limitations.
4. Objective function.

Decision making variables and system limitations are fixed and uncompromising as well and thus have to be fulfilled. Goal limitations have positive and negative deviated variables. The objective is to minimize these deviations from target level or aspiration. Goal Programming minimizes deviations between goals achievement and target level by Lexicographic Goal Programming, Weighted Goal Programming and Chebyshev Goal Programming [41].

In this study, the Weighted Goal Programming process includes:

– the first step, where the weight is determined by pay-off matrix for each one of objectives can be summarized as followed:
  1. A set of the most important objectives for farmers are determined by former studies and questionnaires.
  2. Pay-off matrix will be determined for the goals set in the initial stage.
  3. The set of weights which optimally reflects the real preferences of the farmers is estimated by the pay-off matrix [42–47].
– the second step, where the total weight of positive and negative deviations is minimized from target goal [41].

2.2.1. Variables

The variables include cucumber cultivated areas by any of open field organic farming system and non-organic (common) farming system including open field, tunnel, and greenhouse farming systems.

2.2.2. Experimental objectives of the study include

2.2.2.1. Maximizing gross margin (profit). Obtaining the maximum profit (max GM) is the main motive and objective of every producer. Total gross margin equals the product of the cultivated area of each variable (X_1, X_2, X_3, X_4) by the gross margin of the jth product (GMj). (j is number of variables).

$$Max\ GM = \sum_{j=1}^{m} GM_j \times X_j \quad j = 1, 2, 3, \ldots, m \tag{1}$$

2.2.2.2. Minimizing fertilizer consumption. TF (total fertilizer per hectare) objective is related to environmental indicator and is equal to the sum of the product of each variable (X_1, X_2, X_3, X_4) cultivated area by the amount (kg) of consumed fertilizer of product j (TFj) which must be minimized.

$$MinTF = \sum_{j=1}^{m} TF_j \times X_j \quad j = 1, 2, 3, \ldots, m \tag{2}$$

2.2.3. Limitations

2.2.3.1. Land limitation. Land limitation in the investigated area is considered as varying from 1 to n due to favorable conditions for producing different crops, especially the study sample (i.e. the cucumber). N shows cultivable area in each period (k shows the number of cultivation periods).

$$\sum_{j=1}^{m} X_j \leqslant N_k \quad k = 1, 2, \ldots, n, \quad j = 1, 2, \ldots, m \tag{3}$$

2.2.3.2. Water limitation. Kerman province suffers from severe water resource limitations due to the arid and semi-arid climate of the area and the lack of sufficient rainfall. Maximum used water is investigated in each of the farming systems by considering the amount of water necessary per each hectare of crops.

$$\sum_{j=1}^{m} d_j^{water} \times X_j \leqslant D_k^{water} \quad k = 1, 2, \ldots, n, \quad j = 1, 2, \ldots, m \tag{4}$$

2.2.3.3. Operational capital limitation. Capital is an obligatory factor and thus its limitations are effective. The total capital devoted to a hectare of task in the area is at the right side of capital limitation (R) and the tasks whose coefficients (C) show capital needed for each task in a hectare is at the left side of this limitation.

$$\sum_{j=1}^{m} C_j \times X_j \leqslant R_k \quad k = 1, 2, \ldots, n, \quad j = 1, 2, \ldots, m \tag{5}$$

3. Results

3.1. First step of research: obtaining weight of choices

Drawing decision hierarchy tree is the first necessary step in AHP approach. Decision hierarchy includes: (1) Decision objective, i.e. determining choices weight; research criteria, i.e. environmental and economic indicators; and alternatives (choices), which include open field organic and plastic tunnels, open field, and greenhouse non-organic cucumber (Fig. 1).

In AHP, elements of each level are compared in pair with the related element in the higher level and the weight, called comparative weight, is calculated. Then, the final weight of each choice will be determined by collecting comparative weights and called alternatives (choices) absolute weight (Table 1). Inconsistency rate is a mechanism by which the validity of the responses is evaluated. Almost every calculation of AHP was done according to the respondents' initial judgments that had appeared in paired-comparison matrices. Any error or inconsistency in comparisons and determination of importance between the alternatives will distort the final result. Therefore, Inconsistency rate is a tool that determines inconsistency and shows the extent on which we can rely for prioritizing results from the comparisons. If the Inconsistency rate is 0.1 or less, it shows the consistency in comparisons. The inconsistency rate for economic indicator in this study is $0.01284 < 0.1$ (ok), and for environmental indicator is (ok) $0.01282 < 0.1$.

3.2. The second step of the research: using Weighted Goal Programming model by accounting for the weight (choices) resulted from AHP

Concurrently, the model goals used in this study stand in the same adaptive objective function so that the target function could minimize the total weight of deviational variables between the goal and their acceptable level. Then, the pay-off matrix is used to assign weights to these deviations. With respect to this, the pay-off matrix is determined by optimization of each objective in each row and other objectives are calculated by using parametric calculation [46]. Table 2 shows the pay-off matrix for two considered objectives.

The degree of contrast between the objectives is determined by the pay-off matrix. As shown in the Table 2, there is some degree of contrast between the two objectives of economic profit and utilized chemical fertilizers related to the economic indicator. In current Weighted Goal Program-

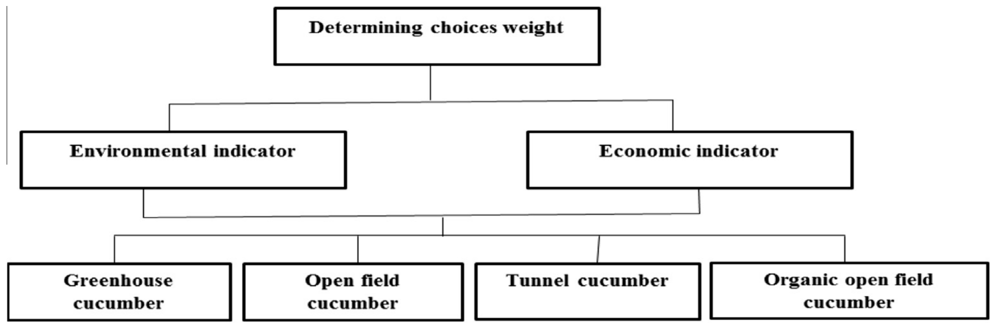

Fig. 1 – Decision hierarchy tree for obtaining choice weight.

Table 1 – Choices (alternatives) absolute weight calculated by AHP.

Alternatives	Open field organic cucumber	Plastic tunnels cucumber	Open field cucumber	Greenhouse cucumber
Alternatives weight (Wj)	0.428	0.112	0.244	0.216

Table 2 – Pay-off matrix for the selected region.

	Gross margin	Total chemical fertilizers and toxins	Real (existing farm plan)
Gross margin	F11	F12	F1
Total chemical fertilizers and toxins	F21	F22	F2

ming, the main diameter elements of the pay-off matrix express the ideal points. In other words, they are optimum for all existing objectives. By using the pay-off matrix information and the following formula, it is possible to calculate normalized weights of objectives as follows:

$$\sum_{j=1}^{m} W_i \times f_{ij} = F_i \qquad \sum_{i=1}^{q} W_i = 1 \tag{6}$$

In addition to the weights of Alternatives achieved by AHP questionnaires (of course, the weights of objectives can be determined by using AHP), the weights of criteria were calculated by using pay-off matrix (Formula 6) in this study. The criteria weight values are as follows:

Economic goal weight: 0.8879
Environmental goal weight: 0.1121

Programming Model is written as follows: by using the weights calculated by AHP (alternatives weights) and pay-off matrix (objectives weight).

$$Min\left\{W_1\frac{n_1}{f_{11}}\times\frac{100}{1}+W_2\frac{p_2}{f_{22}}\times\frac{100}{1}\right\}\overset{\text{subject to}}{\Rightarrow} \tag{7}$$

$$f_{11} = w_1^{AHP}\times GM_1\times X_1 + w_2^{AHP}\times GM_2\times X_2 + w_3^{AHP}\times GM_3 \times X_3 + w_4^{AHP}\times GM_4\times X_4 + n_1 - p_1 \tag{8}$$

$$f_{22} = w_1^{AHP}\times TF_1\times X_1 + w_2^{AHP}\times TF_2\times X_2 + w_3^{AHP}\times TF_3\times X_3 + w_4^{AHP}\times TF_4\times X_4 + n_2 - p_2 \tag{9}$$

$$C_1\times X_1 + C_2\times X_2 + C_3\times X_3 + C_4\times X_4 \leqslant R \tag{10}$$

$$d_1^{water}\times X_1 + d_2^{water}\times X_2 + d_3^{water}\times X_3 + d_4^{water}\times X_4 \leqslant D \tag{11}$$

$$X_1+X_2+X_3+X_4 = N \quad (N = 1,2,\ldots,n) \tag{12}$$

$$X_j, p_j, n_j \geqslant 0 \tag{13}$$

In formula (7), W_1 and W_2 are the weights calculated by the pay-off matrix for objectives of the problem. To homogenize the units of deviating variables, these variables are divided by their right side values and multiplied by 100 (considering this multiplication, target function should be divided into 100 after the calculation to obtain the main value) [41]. The problem variables are X_1, X_2, X_3, X_4 (based on hectares), Eqs. (8) and (9) show goal limitations related to maximum gross margin and minimum chemical fertilizers respectively. Toxins that calculated the weight of choices from AHP (Table 1) are considered in each one of technical coefficients (i.e. the W^{AHP} multiplied by the sum of the product of each variable (X_1, X_2, X_3, X_4) cultivated area by the gross margin of the jth product (GM_j) or the amount of consumed fertilizer of the product j (TF_j). Also, Eqs. (10)–(12) demonstrate research severe (system) limitations such as capital limitations, maximum consumed water limitations and land limitations. In this study, land limitation (considering the favorable condition in Jiroft for cultivating cucumber in different farming systems) ranges from 1 to n (N unit). Finally, Tables 3–5 show the optimization answer for all cultivated areas of 1 to n(N unit) unit by using MATLAB software.

Table 3 – Deviation percentage of the optimum farm plan from existing farm plan (N = 1).

	MCDM model Optimum farm plan	Real model Existing farm plan	Deviation percentage
Gross margin	28.1481	25.1385	+%11.97
Total chemical fertilizers and toxins	21.0396	26.7692	−%21.40
X_1 (greenhouse cucumber cultivated area)	0.1573	0.26	−%39.4987
X_2 (open field cucumber cultivated area)	0.0000	0.24	−%100.0000
X_3 (tunnel cucumber cultivated area)	0.4494	0.30	+%49.8127
X_4 (organic open field cucumber cultivated area)	0.3933	0.20	+%96.6292
$\sum_{i=1}^{4} X_i$	1	1	

Table 4 – Deviation percentage of the optimum farm plan from existing farm plan (N = 99).

	MCDM model Optimum farm plan	Real model Existing farm plan	Deviation percentage
Gross margin	2786.7	2488.7	+%11.97
Total chemical fertilizer and toxin	2082.	2650.2	−%21.40
X_1 (greenhouse cucumber cultivated area)	15.5730	25.7400	−%39.4987
X_2 (open field cucumber cultivated area)	0.0000	23.7600	−%100.0000
X_3 (tunnel cucumber cultivated area)	44.4944	29.7000	+%49.8127
X_4 (organic open field cucumber cultivated area)	38.9326	19.8000	+%96.6292
$\sum_{i=1}^{4} X_i$	99	99	

Table 5 – Deviation percentage of the farm plan from existing farm plan (N = 100).

	MCDM model Optimum farm plan	Real model Existing farm plan	Deviation percentage
Gross margin	2814.8	2513.8	+%11.97
Total chemical fertilizer and toxin	2104.0	2676.9	−%21.40
X_1 (greenhouse cucumber cultivated area)	15.7304	26	−%39.4987
X_2 (open field cucumber cultivated area)	0.0000	24	−%100.0000
X_3 (tunnel cucumber cultivated area)	44.9438	30	+%49.8127
X_4 (organic open field cucumber cultivated area)	39.3258	20	+%96.6292
$\sum_{i=1}^{4} X_i$	100	100	

In this case study, as shown in Tables 3–5, the percentage of the deviations of objectives and areas cultivated by any of organic and non-organic methods in the MCDM proposed plan is stable in comparison with the existing farm plan for different levels of land limitation (from $N = 1, \ldots, 100, \ldots, n$ unit). The value of gross margin positively deviates about 11.97% compared to the existing farm plan and shows that the proposed design is economic in the investigated area.

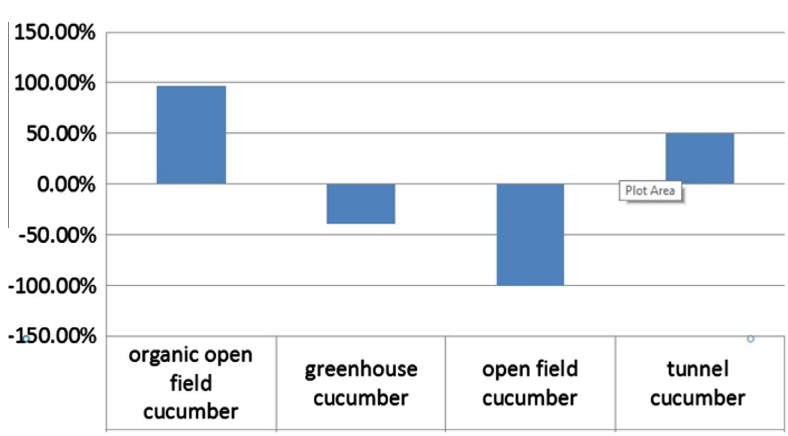

Fig. 2 – Optimum production design in investigated area.

However, the 21.40% decrease of consumed chemical toxins and fertilizers in the proposed plan shows that the environmental indicator in the MCDM-proposed plan significantly improves compared to the existing farm plan, in such a way that the greenhouse cucumber cultivation decreases by 39.50%. Moreover, open field non-organic cucumber cultivating system decreases 100% and open field organic cucumber cultivating system increases by 96.63% (about 100%) in the MCDM-proposed plan. This shows that the cucumber cultivation in open field non-organic method is replaced by cucumber cultivation in open field organic method (Fig 2). This replacement shows the desirability of production by organic farming system by simultaneous consideration of environmental and economic indicators in the investigated area and also indicates that farmers have to move from their current production procedures which utilizes too much chemical fertilizers and toxins to organic production system in order to improve and promote economic and environmental interests and the health of farmers and consumers.

4. Discussion and conclusion

Although not enough attention has been paid to organic agriculture in Iran so far, problems caused by chemical toxins and fertilizers such as human health problems and environmental destruction force us to consider this kind of agriculture system more seriously and identify areas with high potentials for organic cultivation. The importance of addressing the organic agriculture in terms of environmental and health factors and also the long-term adverse effects of using pesticides and chemical fertilizers on human health and the environment highlight the importance of minimizing the application of pesticides and chemical fertilizers to protect the environment. Moreover, obtaining the maximum profit is the main motive and objective of every producer. Therefore, based on environmental and economic indicators (more profitability), minTF and max GM are considered in proposed model. As Didren et al. [17] mentioned land size as the most important factor in accepting organic agriculture, land size in considered as varying from 1 to n due to the proper conditions of study area in this study.

As seen in the proposed MCDM model, open field non-organic production method has been replaced by open field organic production method. Furthermore, the results of this study show that proposed MCDM model is economically justifiable which is consistent with Lund et al. [19] research results. They suggested economic incentive as the most important factor in accepting organic agriculture. Therefore, in proposed MCDM model, economic incentives encourage the producers to replace non-organic method (open field) by organic method (open field). Moreover, less environmental pollution and more profitability in the proposed MCDM model has made organic agriculture a profitable system for producers. This finding is consistent with results of Ash et al. [24] who claim that organic agriculture is more profitable than common agriculture.

Therefore, as the results of this study show that organic agriculture is more profitable than non-organic agriculture, the following suggestions are assumed to be helpful for development of organic agriculture in Iran and enlarging organic cultivation area:

1. This research intended to consider a third indicator i.e. health indicator in addition to economic and environmental indicators. However, because of lack of quantitative data it was not possible we to integrate this indicator in proposed model. Thus it is essential to establish a number of research centers in Iran, such as centers for estimation of health costs incurred by consuming non-organic crops in order to encourage both organic agriculture and marketing of these crops.
2. Different areas of Iran have to be investigated in terms of feasibility of producing and developing organic cultivation by using different optimization models such as Lexicographical Programming and Dynamic Linear Programming [24]. This will also help identify potential areas and use these areas to improve the function of organic producers by the unit of area.
3. Increasing the demand for the production of organic crops requires extensive research to determine areas of the country which have high potentials for producing organic crops, while considering indicators such as economic (maximizing gross margin), environmental (minimizing chemical toxins and fertilizers usage), and health (minimizing health costs) indicators.
4. Because the demand for these kinds of crops in Iran is low due to their high prices, fixing the guaranteed purchase price for organic crops by the government plays an important role in creating economic motivation for farmers to produce these kinds of crops. Therefore, this guaranteed purchase price stimulates the production, reduces the prices and finally increases the demand for organic products which consequently promotes the competition among farmers to convert their production methods to organic methods.

REFERENCES

[1] Rodríguez EMM, Gentile N, Lupín B, Garrido L. El mercado interno de alimentos orgánicos: Perfil de los consumidores argentinos, Comunicación presentada en Reunión Anual de la Asociación Argentina de Economía Agraria, 33, Buenos Aires [ARG], octubre 2002;6(1):23–6.
[2] Bagheri A, Fami H, Rezvanfar A, Yazdani S. Analyzing application of sustainable agricultural technologies among paddy farmer in Haraz Catchments area, Mazandran province of Iran. J Agric Sci 2008;392(1):139–52.
[3] Edwards CA, Lal R, Madden P, Miller RH, House G. Sustainable Agric Syst 1989:8–9.
[4] Pimentel D, Hepperly P, Hanson J, Douds D, Seidel R. Environmental, energetic, and economic comparisons of organic and conventional farming systems. BioScience 2005;55(7):573–82.
[5] Patil S, Reidsma P, Shah P, Purushothaman S, Wolf J. Comparing conventional and organic agriculture in Karnataka, India: where and when can organic farming be sustainable? Land Use Policy 2014;37:40–51.

[6] Wright S, McCrea D. Handbook of organic food processing and production. Springer; 2000. p. 31–55.
[7] Aertsens J. Organic food as an emerging market: personal determinants of consumption, supply governance and retail strategies. Ghent University; 2011. p. 52–164.
[8] Bonti-Ankomah S, Yiridoe EK. Organic and conventional food: a literature review of the economics of consumer perceptions and preferences. Final Report. 2006. p. 9–14.
[9] Makatouni A. What motivates consumers to buy organic food in the UK? Results from a qualitative study. Br Food J 2002;104 (3/4/5):345–52.
[10] Klonsky K, Tourte L, Thompson GD, Lohr L, Krissoff B. Emergence of us organic agriculture: can we compete?: University of Georgia, Department of Agricultural and Applied Economics; 1998. p. 1130–3.
[11] Govindasamy R, Italia J. Predicting willingness-to-pay a premium for organically grown fresh produce. J Food Distrib Res 1999;30:44–53.
[12] Conti S, Villari G, Faugno S, Melchionna G, Somma S, Caruso G. Effects of organic vs. conventional farming system on yield and quality of strawberry grown as an annual or biennial crop in southern Italy. Sci Hortic 2014;180:63–71.
[13] Caruso G, Conti S, La Rocca G. Influence of crop cycle and nitrogen fertilizer form on yield and nitrate content in different species of vegetables. Adv Hortic Sci 2011;25(2):81–9.
[14] Caruso G, Villari G, Borrelli C, Russo G. Effects of crop method and harvest seasons on yield and quality of green asparagus under tunnel in southern Italy. Adv Hortic Sci 2012;26(2):51–8.
[15] Dangour A, Dodhia S, Hayter A, Aikenhead MA, Allen E, Lock K, et al. Comparison of composition (nutrients and other substances) of organically and conventionally produced foodstuffs: a systematic review of the available literature. Report for Food Standard Agency London: London School of Hygiene & Tropical Medicine; 2009. p. 5–6.
[16] Lili Z, Tong C. Consumer perception of organic food in Urumqi. Bologna, Italy: International Marketing and International Trade of Quality Food Products; 2007. p. 175–6.
[17] Diederen P, van Meijl H, Wolters A. Modernisation in agriculture: what makes a farmer adopt an innovation? Int J Agric Resour Governance Ecol 2003;2(3–4):328–42.
[18] Tatlıdil FF, Boz İ, Tatlidil H. Farmers' perception of sustainable agriculture and its determinants: a case study in Kahramanmaras province of Turkey. Environ Dev Sustainability 2009;11(6):1091–106.
[19] Lund V, Hemlin S, Lockeretz W. Organic livestock production as viewed by Swedish farmers and organic initiators. Agric Hum Values 2002;19(3):255–68.
[20] Dabbert S, Haring AM, Zanoli R. Organic farming: policies and prospects. Zed Books; 2004. p. 46–114.
[21] Eyhorn F, Ramakrishnan M, Mäder P. The viability of cotton-based organic farming systems in India. Int J Agric Sustainability 2007;5(1):25–38.
[22] Pawar C. Organic farming: generality, status, definition, methodology and benefits. Mandvi: Shree Vivekanand Training and Research Institute; 2007.
[23] Blaise D, Rupa T, Bonde A. Effect of organic and modern method of cotton cultivation on soil nutrient status. Communic Soil Sci Plant Anal 2004;35(9–10):1247–61.
[24] Acs S, Berentsen P, Huirne R. Conversion to organic arable farming in The Netherlands: a dynamic linear programming analysis. Agric Syst 2007;94(2):405–15.
[25] Thapa GB, Rasul G. Patterns and determinants of agricultural systems in the Chittagong Hill Tracts of Bangladesh. Agric Syst 2005;84(3):255–77.
[26] Gunnarsson C, Hansson P-A. Optimisation of field machinery for an arable farm converting to organic farming. Agric Syst 2004;80(1):85–103.
[27] Sartori L, Basso B, Bertocco M, Oliviero G. Energy use and economic evaluation of a three year crop rotation for conservation and organic farming in NE Italy. Biosyst Eng 2005;91(2):245–56.
[28] Entz M, Guilford R, Gulden R. Productivity of organic cropping in the Eastern Prairies: On-farm survey and database development. University of Manitoba. Website: [http:// www.umanitoba.ca/faculties/afs/plant_science/extension/organic.html]; 2000.
[29] Dobbs TL, Smolik JD. Productivity and profitability of conventional and alternative farming systems: A long-term on-farm paired comparison. J Sustainable Agric 1997;9 (1):63–79.
[30] Clark S, Klonsky K, Livingston P, Temple S. Crop-yield and economic comparisons of organic, low-input, and conventional farming systems in California's Sacramento Valley. Am J Altern Agric 1999;14(03):109–21.
[31] Hanson JC, Lichtenberg E, Peters SE. Organic versus conventional grain production in the mid-Atlantic: an economic and farming system overview. Am J Altern Agric 1997;12(01):2–9.
[32] Center lR. Investigating the Condition of Organic Agriculture. 2011 (in Iran).
[33] FAOSTAT; 2010.
[34] Romero C. Handbook of critical issues in goal programming. Pergamon Press; 1991. p. 3–38.
[35] Bruce L, Golden BL, Wasil EA, Harker PT. Analytic hierarchy process. Berlin Heidelberg: Springer; 2003. p. 1–2.
[36] De Luca AI, Iofrida N, Strano A, Falcone G, Gulisano G. Social life cycle assessment and participatory approaches: a methodological proposal applied to citrus farming in Southern Italy. Integr Environ Assess Manage 2015;11 (3):383–96. http://dx.doi.org/10.1002/ieam.1611.
[37] Saaty T. The analytic hierarchy process. McGraw-Hill; 1980. There is no corresponding record for this reference. 1980:8-13.
[38] Saaty TL. How to make a decision: the analytic hierarchy process. Eur J Oper Res 1990;48(1):9–26.
[39] Saaty TL, Vargas L. Prediction, projection and forecasting: applications of the analytic hierarchy process in economics, finance. Politics, Games and Sports; 1993.
[40] Satty TL, Vargas LG. Models, methods, concepts and applications of the analytic hierarchy process. Int Ser Oper Res Manage Sci 2001;34:1–352.
[41] Romero C, Rehman T. Multiple criteria analysis for agricultural decisions. Elsevier; 2003. p. 21–45.
[42] Manos B, Begum MAA, Kamruzzaman M, Nakou I, Papathanasiou J. Fertilizer price policy, the environment and farms behavior. J Policy Model 2007;29(1):87–97.
[43] Manos B, Bournaris T, Chatzinikolaou P, Terzi M, Kiomourtzi F. Tobacco alternatives in Greece. A preliminary evaluation and classification. New Medit 2008;7(3):14–8.
[44] Manos B, Bournaris T, Kamruzzaman M, Begum M, Anjuman A, Papathanasiou J. Regional impact of irrigation water pricing in Greece under alternative scenarios of European policy: a multicriteria analysis. Reg Stud 2006;40(9):1055–68.
[45] Manos B, Bournaris T, Papathanasiou J, Voudouris K, Kazakis N, Tagarakis A, et al. Transnational integrated management of water resources in agriculture for european water emergency control (EU-WATER); 2012. p. 15–35.
[46] Manos B, Chatzinikolaou P, Kiomourtzi F. Sustainable optimization of agricultural production. APCBEE Proc 2013;5:410–5.
[47] Manos B, Papathanasiou J, Bournaris T, Voudouris K. A multicriteria model for planning agricultural regions within a context of groundwater rational management. J Environ Manage 2010;91(7):1593–600.